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# EC757 Revised 1938 Irrigation Structures and Equipment

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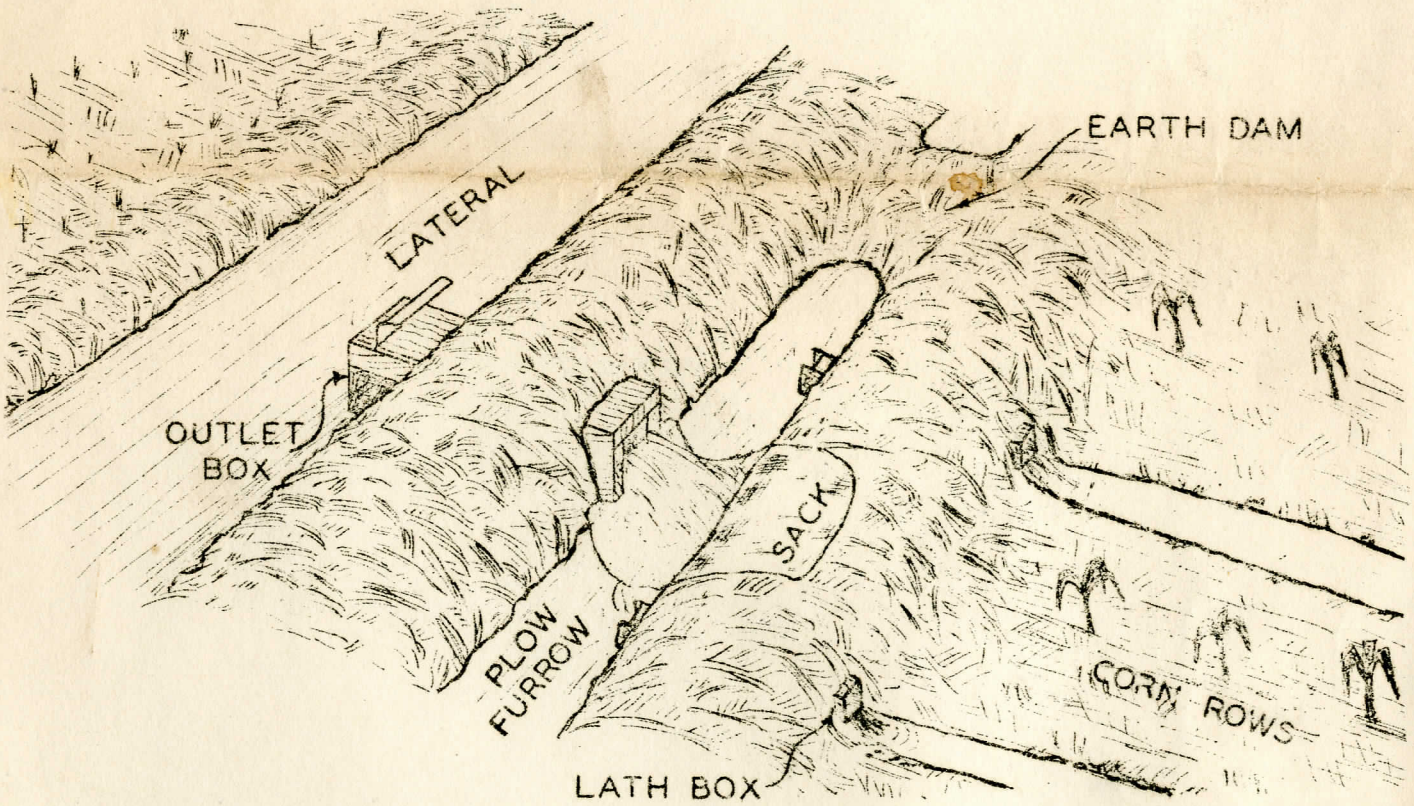
# IRRIGATION STRUCTURES AND EQUIPMENT




Prepared by

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# IRRIGATION STRUCTURES AND EQUIPMENT

by

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The equipment described in this circular is not of new or original design. The ditcher, the land leveler, the dams and other features are used almost everywhere in the western states by experienced irrigators. The purpose of this circular is to familiarize those who are using water for the first time with those items of equipment which will save labor and make for greater efficiency.

## Land Leveling.

Land surfaces, as left by natural forces, are seldom smooth enough to permit irrigation water to spread evenly over them or to run down rows uniformly without considerable work being expended in leveling. Major elevations and depressions may be removed with Fresnos or slip scrapers, road graders or other heavy machinery but it is equally important that minor irregularities be removed. This can be done with a leveling drag such as is depicted on the following pages.

When humps or elevated portions of a field are removed with heavy machinery, often no top soil is left while the low spot which has been filled may have a greater depth of it than is necessary. The new irrigator may often find it to his advantage to irrigate those portions of his fields which can be handled with the least leveling allowing the rougher portions to go un-watered until a later time. The irrigation drag does a gradual job of leveling and if used through the years will pay big dividends in time saved. Fields which have smooth uniform surfaces ordinarily irrigate well.

## Water Control Important.

Much of the hard work and trouble ordinarily associated with the irrigation of crops is occasioned by a lack of proper equipment for handling water. The irrigator who simply cuts the bank of the lateral and allows a stream to flow to a row crop will ordinarily have to exert himself unduly to keep the bank from eroding or all of the flow from going down one or two rows.

Ditch checks or dams which will allow some of the supply to be by-passed on down the lateral, outlet boxes which permit an operator to take water from a lateral without eroding the banks and lath boxes which permit a uniform supply to be measured to each row are items of equipment which save a great deal of labor and often produce much more satisfactory yields because of more uniform distribution.

Beginners in irrigation seldom build ditches which are of sufficient size to carry a heavy flow without breaks. Too often the banks do not contain sufficient dirt to stand heavy usage. The water surface in irrigation laterals ordinarily stands 6 inches or more above the land surface when a check dam is used. A small, poorly constructed ditch will immediately give trouble under these conditions and occupy most of the operator's time in mending breaks. A heavy, well constructed ditcher when drawn by a 15-30 tractor will produce a lateral which will stand up through the whole irrigation season without trouble.

# THE IRRIGATION LEVELING DRAG

## Construction Features.

In order to produce the best quality of work, the leveling drag should be of considerable length. The action of the leveling drag is very much like that of a plane smoothing a piece of wood. A short block plane will not produce a smooth surface on an irregular board, whereas a long joining plane removes the elevated places and soon produces a uniform surface.

Figure No. 1 shows the general features of construction. There are two long side pieces marked (A). These may be of 2" x 12" or 3" x 12" material with a minimum length of 18', even 24' or 30' will not be too long. The width should not be greater than 8' for ordinary purposes. Note that there are three cross-pieces each marked (C). The front one and back one are mounted rigidly and set at an angle as shown by the detail sheet, Figure No. 3. The center cross-piece is mounted on a 2" pipe, the fastening being made by "U" bolts marked (J).

The top of the structure is braced with 2" x 6"'s marked (B) and two 5/8" rods marked (H) serve to hold the side pieces rigidly together. All parts must be securely nailed with 20d or 30d nails. Chains for pulling the drag are attached at "K", which consists of heavy strap irons well bolted to the side pieces. It should be noted that a piece of angle iron is attached to the lower edge of each of the cross-pieces and that a heavy strap iron or a piece of wagon tire is mounted along the bottom edge of the side pieces as shown in Figure No. 3.

## Action of the Drag.

As the drag is pulled forward, the cross-pieces have a tendency to crush clods and to move dirt from the high to the low places. The center cross-piece being movable, may be set straight or at an angle. It will be noted that the upright piece of 2" x 6" (F) is rigidly attached to the middle cross-piece. A rope may be tied from the top end of (F) to some part of the frame. This will hold the middle cross-piece in any desired position. If the ground is slightly wet, it may be necessary to set the center cross-piece at a considerable angle. If a large quantity of dirt collects within the drag, it may be necessary to release the upright (F) in order to dump the dirt in a low spot. It should be noted that the 2" pipe to which the center cross-piece is bolted is mounted a considerable distance above the center of the side member (A).

## Use of the Drag.

Irregularities in the ground upon which irrigation is contemplated can be partially removed by the use of some sort of leveling drag which is of considerable length. The equipment shown in the drawings, under favorable conditions, will require the services of a 10-20 tractor or approximately 6 horses to pull it. When the soil is fairly dry, the field may be dragged lengthwise, cornerwise and crosswise. Care must be used not to produce a pulverized condition which is conducive to soil blowing.

BILL OF MATERIAL
for
IRRIGATION LEVELING DRAG
shown in Figure No. 1

(A) 2 - 2" x 12" x 22'-0"

(B) 2 - 2" x 6" x 14'-0"
2 - 2" x 6" x 12'-0"

(C) 3 - 2" x 12" x 8'-0"

(D) 2 - 2" x 8" x 8'-0"

(E) 1 - 2" x 4" x 6'-0"

(F) 1 - 2" x 6" x 6'-0"

(G) 1 - 2" x 8' - 8" iron pipe.
Both ends threaded.

(H) 2 - 5/8" x 8'-6" rods.
Both ends threaded.
4 - 5/8" extra heavy washers
4 - 5/8" nuts.

(J) 3 - 5/8" U bolts
6 - 5/8" washers

(K) 2 - 3/16" x 1-5/8" x 50" strap iron.
6 - 3/8" x 2½" bolts.

(L) 2 - 3/16" x 8" x 8" sheet iron
4 - 1-3/4" No. 10 screws F.H.B.

(M) 2 - 3/16" x 1-5/8" x 19'-0" strap iron
Holes drilled 1'-0" apart for screws-countersunk.
40 - 2" No. 10 screws F.H.B.

(N) 3 - 3/16" x 1-5/8" x 2½" angle iron or 3 iron blades.
Holes drilled for screws - countersunk. 54 - 1-3/4" No. 10 screws F.H.B.

(O) 2 - Clevis

Nails

2 pounds 20d
1 pound 30d
1½ " 40d

Other Equipment for Land Leveling.

The leveling drag described in this circular is not the only design which has proven successful. Some farmers have built the drag as described but have added a set of trucks which permitted the front end to be raised with a lever in turning. Others have used a different arrangement of the center cross-piece, mounting it in a way which permitted it to be slid up and down in a groove rather than tilted as shown.

Upon request, plans for the home-made buck scraper, the border drag and other miscellaneous equipment can be had.

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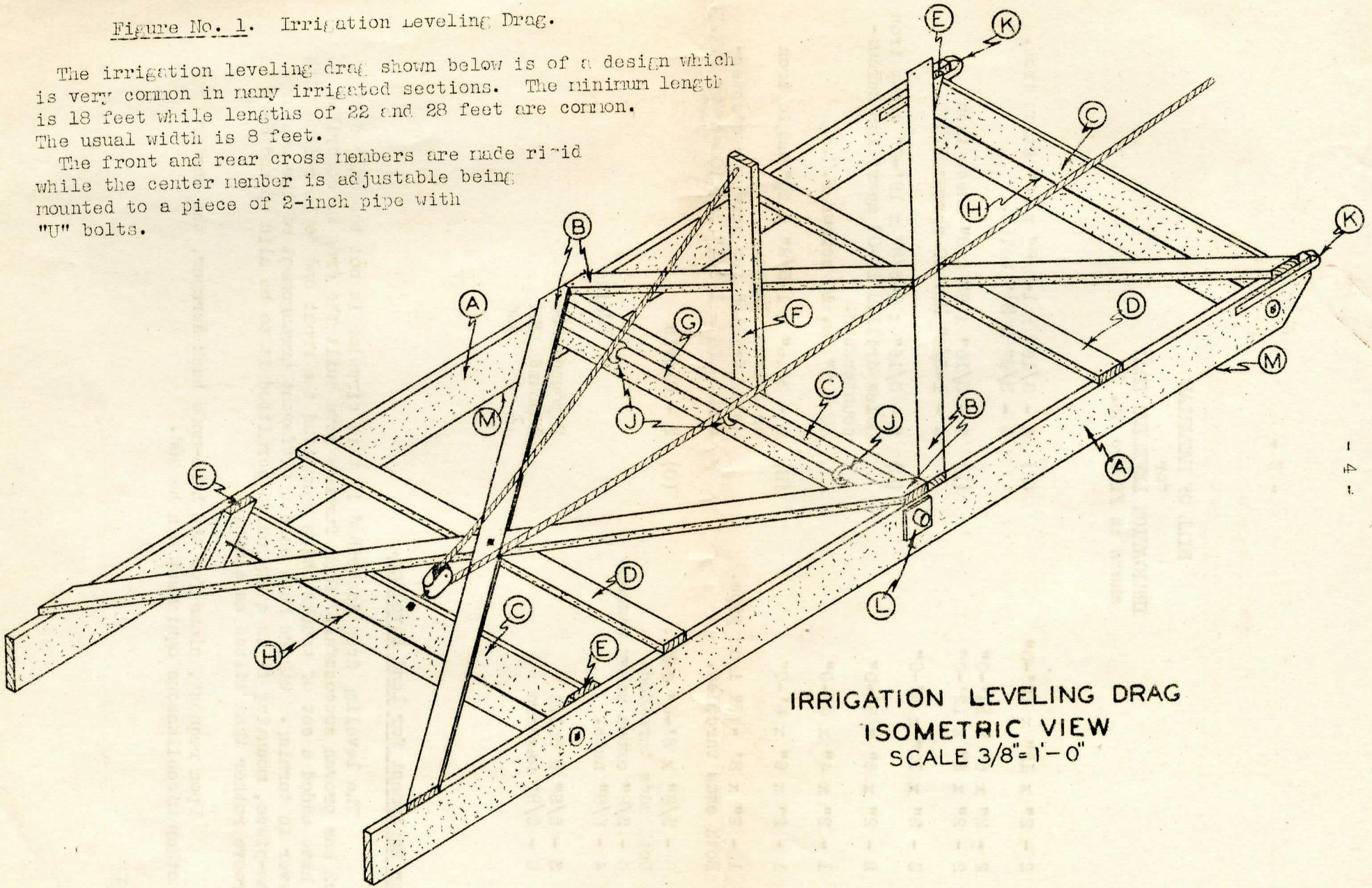
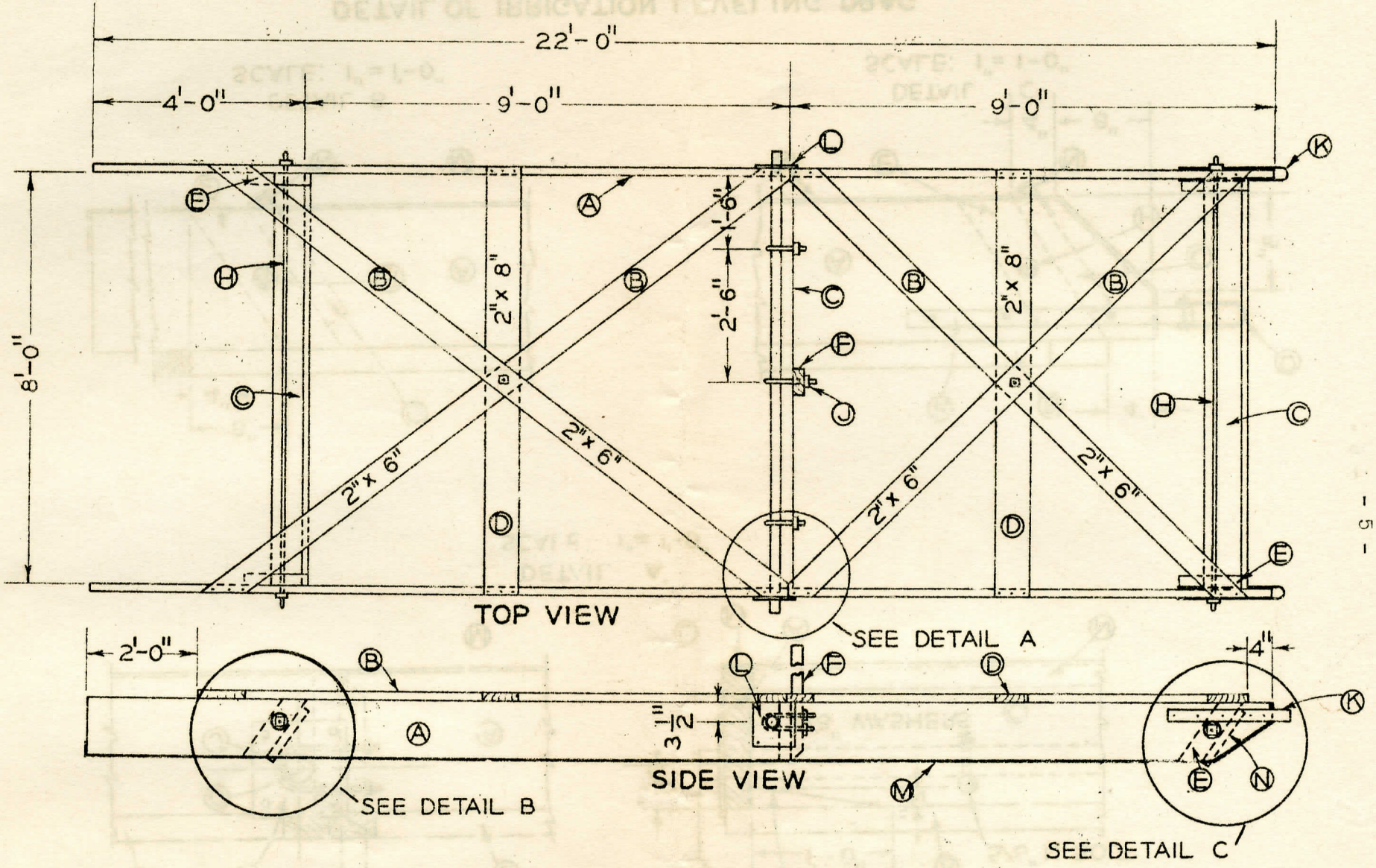
Figure No. 1. Irrigation Leveling Drag.

The irrigation leveling drag shown below is of a design which is very common in many irrigated sections. The minimum length is 18 feet while lengths of 22 and 28 feet are common. The usual width is 8 feet.

The front and rear cross members are made rigid while the center member is adjustable being mounted to a piece of 2-inch pipe with "U" bolts.

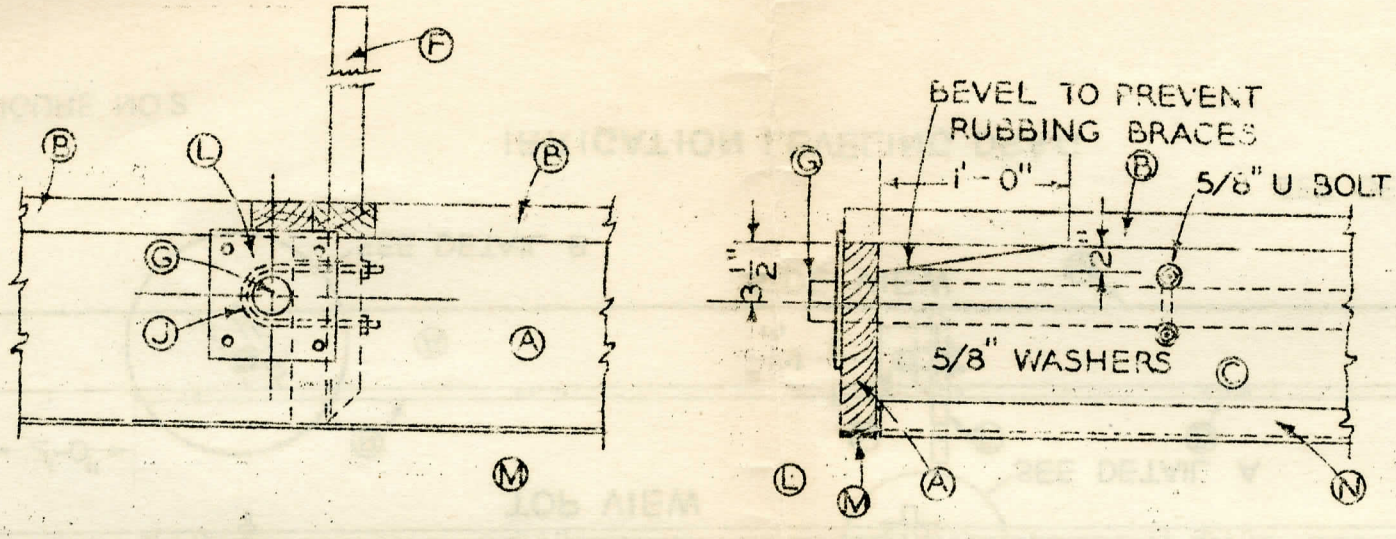



IRRIGATION LEVELING DRAG
ISOMETRIC VIEW
SCALE 3/8"=1'-0"

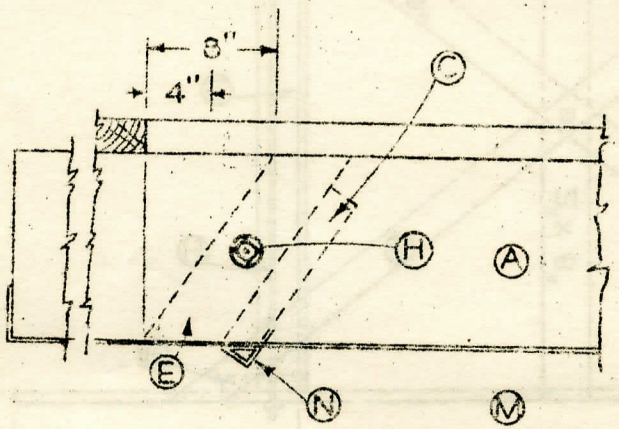



IRRIGATION LEVELING DRAG

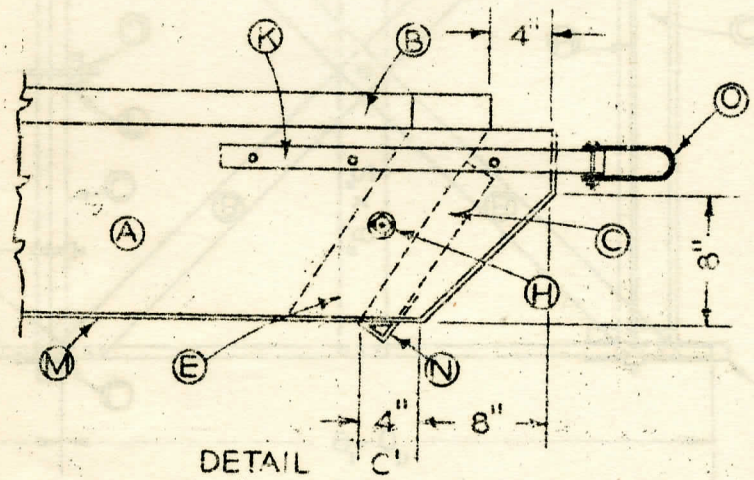
FIGURE NO. 2




DETAIL A'
SCALE: 1"= 1'-0"




DETAIL B'
SCALE: 1"= 1'-0"




DETAIL C'
SCALE: 1"= 1'-0"

DETAIL OF IRRIGATION LEVELING DRAG

FIGURE NO.3

## IRRIGATION DITCHER

Regarding Patent Rights.

The irrigation ditcher shown in Figure No. 4 has been built for years in blacksmith shops and used in a number of western states. Some features may be covered by patent rights and no attempt has been made in this circular to discover which features may be so covered. Anyone constructing the ditcher for sale may run the risk of patent enfringement.

Construction Features.

The principal parts as shown in Figure No. 4 consist of a heavy "V" made of 3" x 12" plank 6 feet long. The surface of these plank is covered with 16-gauge galvanized iron. The cutting edge of the "V" is made of angle iron which is ground to a fairly sharp edge. Difficulty will be encountered by attempting to shape the angle iron by pounding it out.

The ditcher is drawn by a heavy tongue made of 4" x 6" hickory or oak. This is rigidly attached to the interior of the "V", as shown in the drawings.

On the bottom of the ditch slides a member known as a "skid" which is attached to the rear end of the "V" by adjustable iron. By raising the back end of the "V", a narrow, deep ditch can be made or by lowering it a wide, shallow one. The point of the ditcher shown at (O) in the various drawings is often made of an old lister point.

Anyone constructing the ditcher should follow through from the drawings shown in Figures 4, 5, and 6 to the bill of material.

Action of the Ditcher.

The ditcher is hitched behind a tractor by a length of chain varying from two to four feet. Oftentimes, a lister furrow is plowed first as a guide. One man takes his station behind the ditcher and grasps the handles to hold the implement in an upright position. The amount to raise the back end of the ditcher can be determined only by trial. Adjustments as to hitch will often be necessary before the machine will work correctly. Ordinarily, two rounds will be sufficient unless the ground is extremely hard. A row crop type of tractor of the 15-30 size is a convenient form of power. The wheels can be spread wide enough on this machine to go either side of the ditch. Some packing of the dirt thrown out in the first round is not undesirable.

In extremely hard ground, it is sometimes necessary to go through with a plow after the first round to loosen up the soil in the bottom of the partly finished ditch.

Finishing the Ditch.

After a lateral is constructed with the ditcher, it will be found very advantageous to make one round with a walking plow drawn by a team throwing the ditch towards the sides of the lateral. This puts additional dirt in the banks which will be found an added factor of safety when carrying a heavy head of water.

BILL OF MATERIAL FOR IRRIGATION DITCHER

Shown in Figure No. 4

Wood

(A) 2 - 3" x 12" x 6'-0" bridge plank (sides)
(B) 1 - 4" x 6" x 8'-0" hickory or oak (tongue)
(C) 2 - 2" x 12" x 2'-6" pine (spreaders)
(D) 1 - 4" x 4" x 6'-0" hickory or oak (skid)

Iron

(E) 2 - $\frac{1}{2}$" x 1$\frac{1}{2}$" x 3'-0" strap iron (height adjusters)
(F) 1 - $\frac{1}{2}$" x 2" x 3'-4" strap iron (skid support)
(G) 2 - $\frac{1}{2}$" x 1$\frac{1}{2}$" x 2'-0" strap iron (handles)
(H) 2 - $\frac{1}{2}$" x 1$\frac{1}{2}$" x 1'-9" strap iron (height adjuster checks)
(J) 2 - 1$\frac{1}{2}$" x 1$\frac{1}{2}$" x 6'-0" angle iron (side shoes)
(K) 4 - 1$\frac{1}{2}$" x 1$\frac{1}{2}$" x 1'-0" angle iron (spreader supports)
(L) 1 - $\frac{1}{2}$" x 2$\frac{1}{2}$" x 1'-8" strap iron
(M) 1 - $\frac{1}{2}$" x 2$\frac{1}{2}$" x 2'-6" strap iron (clevis)
(N) 2 - 3/8" x 4" diam. rings (clevis)
(O) 1 - 3/8" flat plate 6$\frac{1}{2}$" x 5"
(P) 1 - $\frac{1}{2}$" x 2" x 1'-4" strap iron (skid clevis)
(Q) 1 - 3/8" x 4" x 5'-6" strap iron (skid shoe)
(R) 2 - 12" x 6'-0" #16 gauge galv. iron (side protection)

SPECIAL NOTE.

Many of the items shown in this bill of material are not carried in the stock of the ordinary blacksmith shop or hardware store and will have to be ordered specially.

Bolts

(S) 1 - 3/4" x 24"
2 - 5/16" x 1-1/2" ---'U' piece elevator (E)
2 - 5/16" x 7" ---tongue clevis (A), to (B)
2 - 3/8" x 7" ---tongue skid (L), to (B)
2 - 3/8" x 9-3/4" ---tongue, to crossboards(C)
4 - 5/16" x 3" ---elevator guides (E), to crossboards (C).
8 - 1/4" x 2-1/4" ---angle iron (K), to crossboards (C).
10 - 1/4" x 3-3/4" ---8 from angle iron (K), to beam (A). 2 for top bolts in handles.
4 - 3/8" x 4-1/2" ---bottom skid (Q) to beam (D)
6 - 3/8" x 3-1/2" ---angle iron (J) to beam (A)
2 - 3/8" x 1" ---triangular plate (O), to angle iron (J)
4 - 3/8" x 4" ---front 'U' iron (F) to beam (A)
1 - 3/8" x 6" ---front 'U' iron (F) to tongue (B)
1 - 3/8" x 5" ---'U' piece elevator (E) to skid (D)
2 - 3/8" x 2" ---lag screws for handles

Nails

Approximately 100 - 8 penny wire
Half-dozen large spikes.

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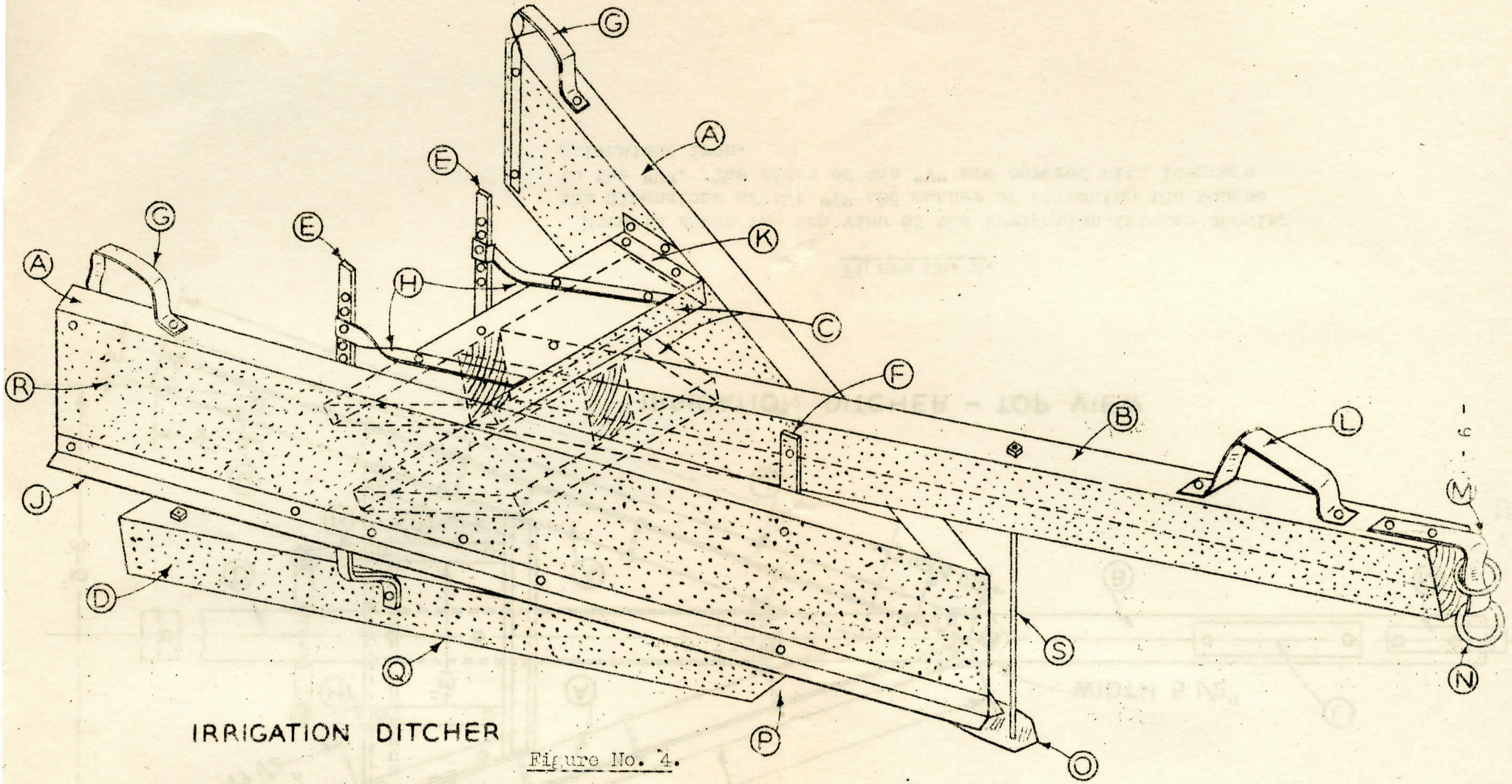
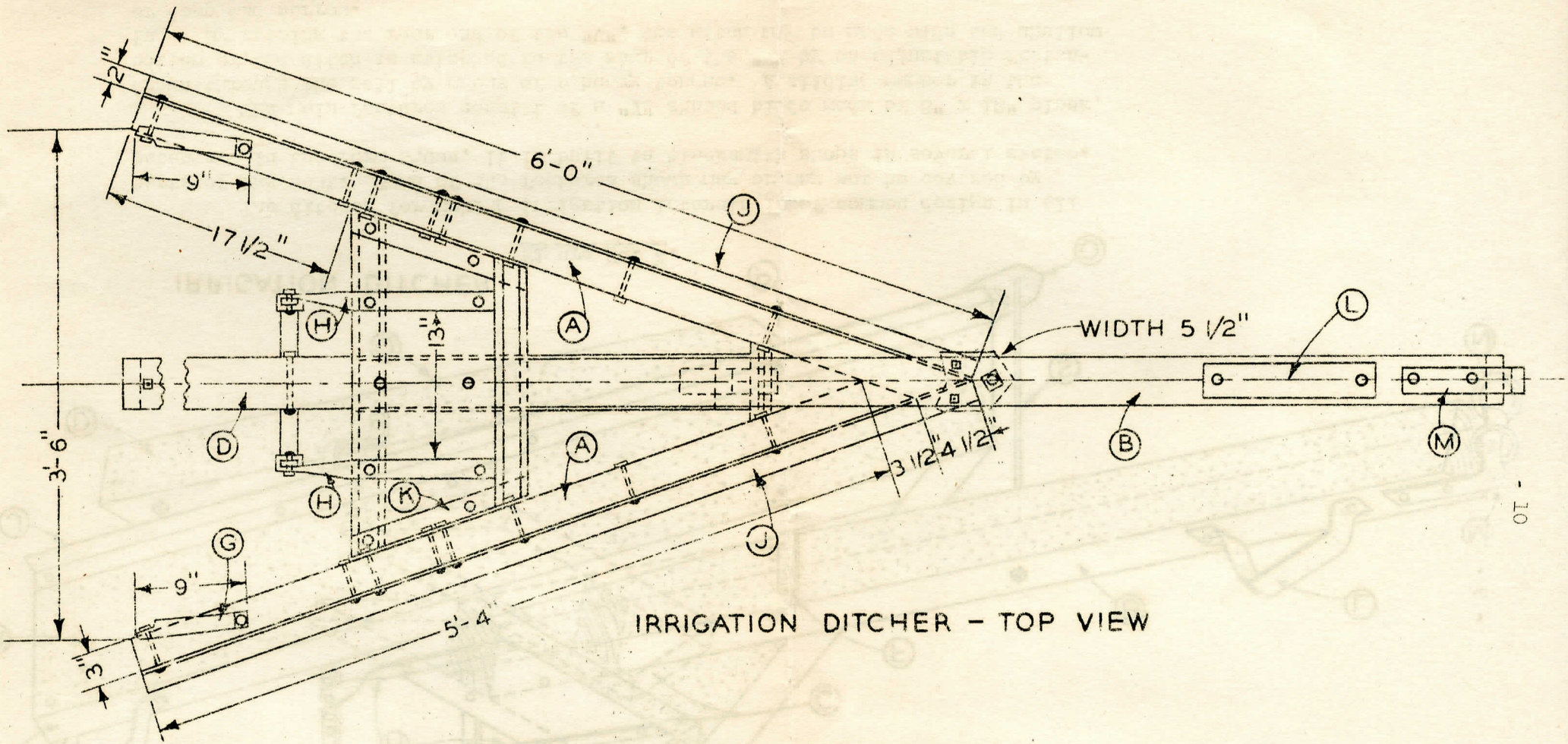



IRRIGATION DITCHER

Figure No. 4.

The ditcher for making irrigation laterals is of common design in all parts of the west. Some of the features shown may or may not be covered by patents. In the form shown, it is built in blacksmith shops in several states.

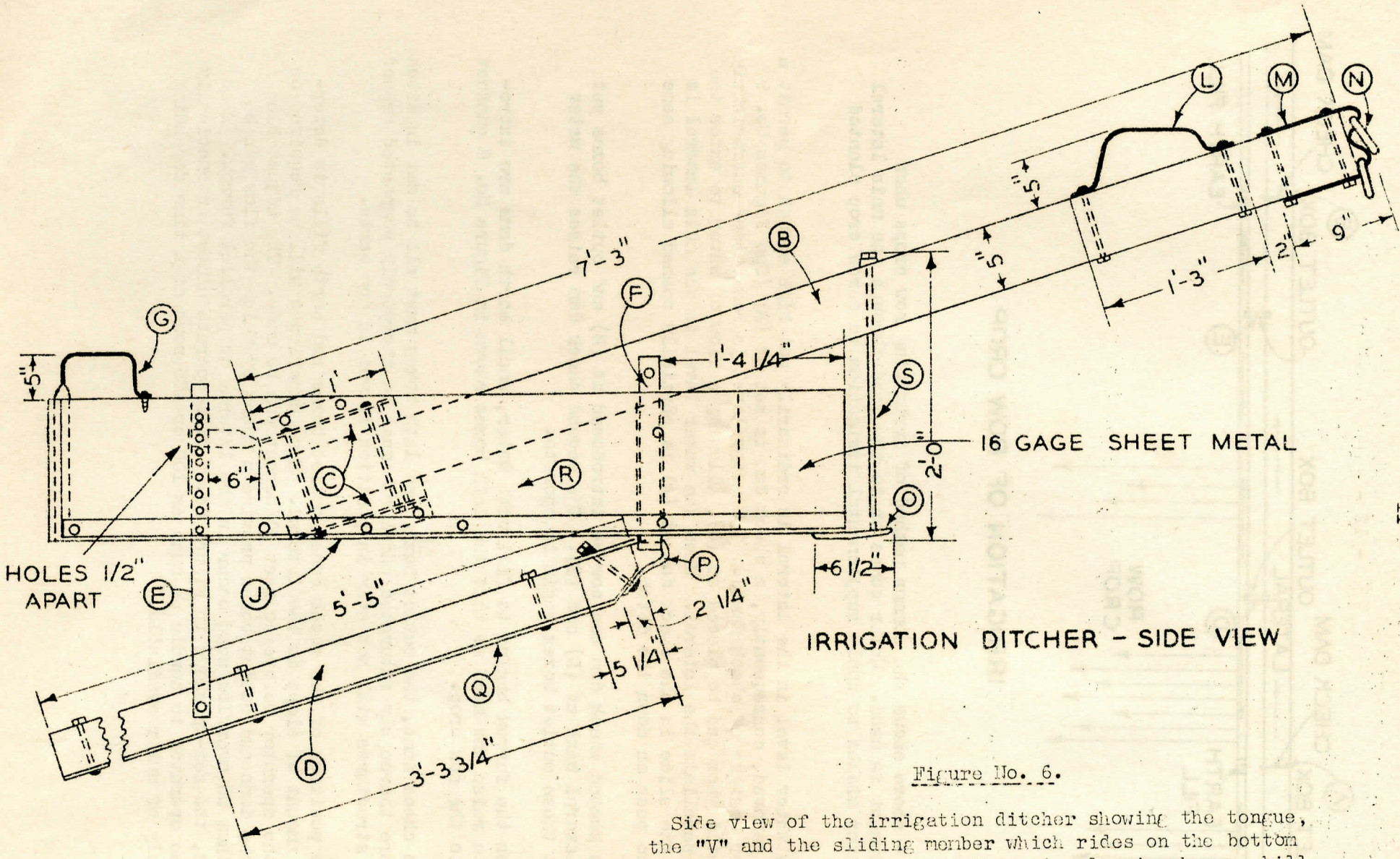
The main features consist of a "V" shaped blade made of 3" x 12" plank, drawn through the soil by means of a heavy tongue. A sliding member in the bottom of the ditch is attached to the rear of the "V" by an adjustable fastening. By raising the rear end of the "V", the ditch may be made wide and shallow or deep and narrow.




IRRIGATION DITCHER - TOP VIEW

Figure No. 5.

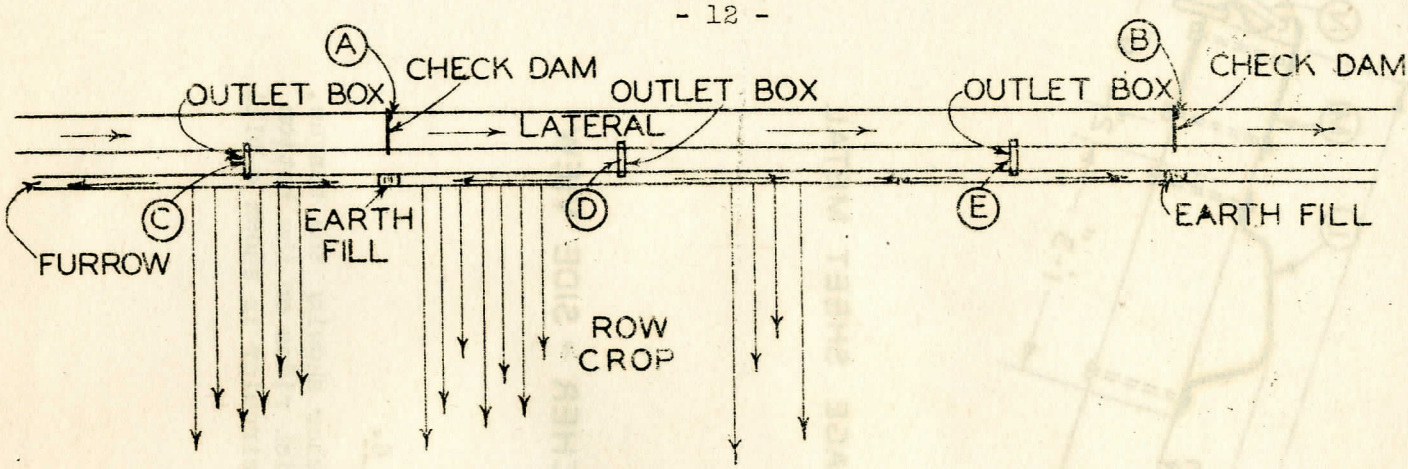
Here is shown the top view of the irrigation ditcher showing the dimensions of the "V" and manner of attaching the tongue to the "V". The sides of the "V" are covered with 16-gauge galvanized iron.




IRRIGATION DITCHER - SIDE VIEW

Figure No. 6.

Side view of the irrigation ditcher showing the tongue, the "V" and the sliding member which rides on the bottom of the ditch. Elsewhere in this circular is shown a bill of material.




IRRIGATION OF ROW CROP

Figure No. 7 - above shows the common method of irrigating row crops when adequate equipment is used. Water comes on to the land through the main lateral and the operator wishes to apply supplemental irrigation to a row crop planted as shown.

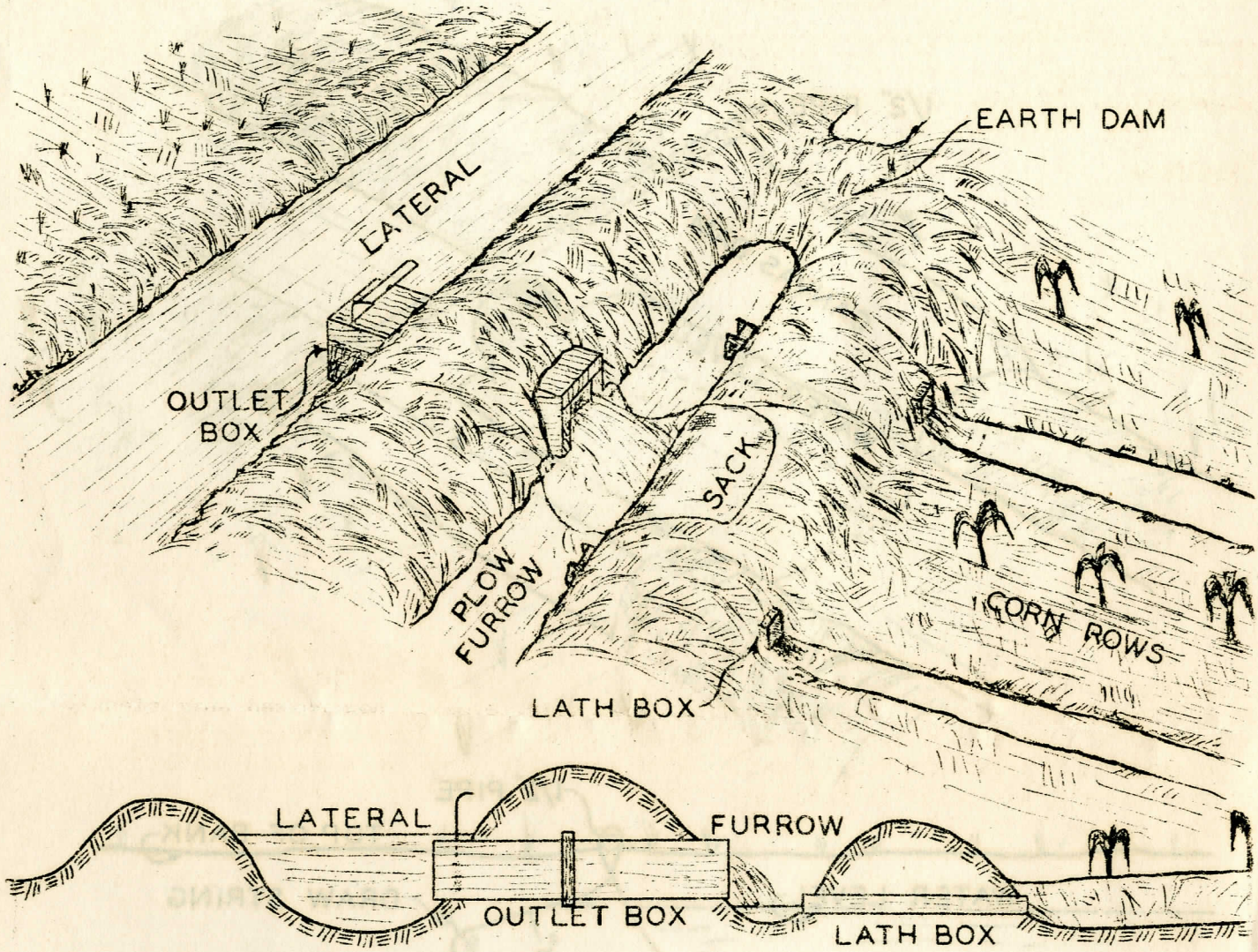
The water level in the lateral is ordinarily not high enough to permit a supply to be removed, consequently, a check dam is set at (A) (See Figures No. 9 and No. 10 for designs of check dams). The water level is now raised sufficiently so that an outlet box can be placed at (C), allowing a flow of water to enter the furrow which parallels the lateral. When the water level in the main lateral is high enough, the slide in the check dam at (A) is partially opened allowing some of the flow to pass on down the ditch.

The second check dam can now be introduced at (B) and outlet boxes put through the lateral bank at (D) and (E). The second check dam raises the water level so that these outlet boxes begin to operate.

When the furrow begins to fill with water, small earth dams are introduced in it to raise the head so that the lath boxes shown in Figure No. 8 conduct the water into the row crop.

The check dams, the outlet boxes and lath boxes must all be set in ditch banks which are thoroughly saturated and earth must be thoroughly compacted around them. These structures will not stay in position if put in dry earth.

The position of the check dams, outlet boxes and earth fills is determined by the amount of slope in the lateral. Some experience will be required on the part of the operator before correct placement can be made. The adjustable openings in the dams and outlet boxes provide a means by which the flow can be balanced so that no overflow need occur in the lateral or parallel furrow. When once adjusted, the set-up shown in Figure No. 7 will operate almost automatically permitting one operator to handle as much as 100 or 175 rows at a time depending upon the supply of water available.




OUTLET BOX AND LATH BOX

Figure No. 8.

Above is shown the arrangement of outlet box and lath boxes commonly used in the irrigation of row crops such as potatoes, corn or beets. The water level in the lateral is raised by means of a check dam and by raising the slide in the outlet box a flow is allowed to enter the plow furrow or small ditch which parallels the lateral.

From the plow furrow, a flow is measured into each row by means of a lath box set in the bank of the plow furrow. By varying the head of water over the end of the lath, the amount of water flowing in each row can be varied. To prevent trash and leaves from clogging the box, the ends are cut as shown in Figure No. 12.

One outlet box will furnish water for from 12 to 20 lath boxes. The method of balancing the flow from one check dam to another and from the lateral ditch to the plow furrow is described in connection with Figure No. 9.

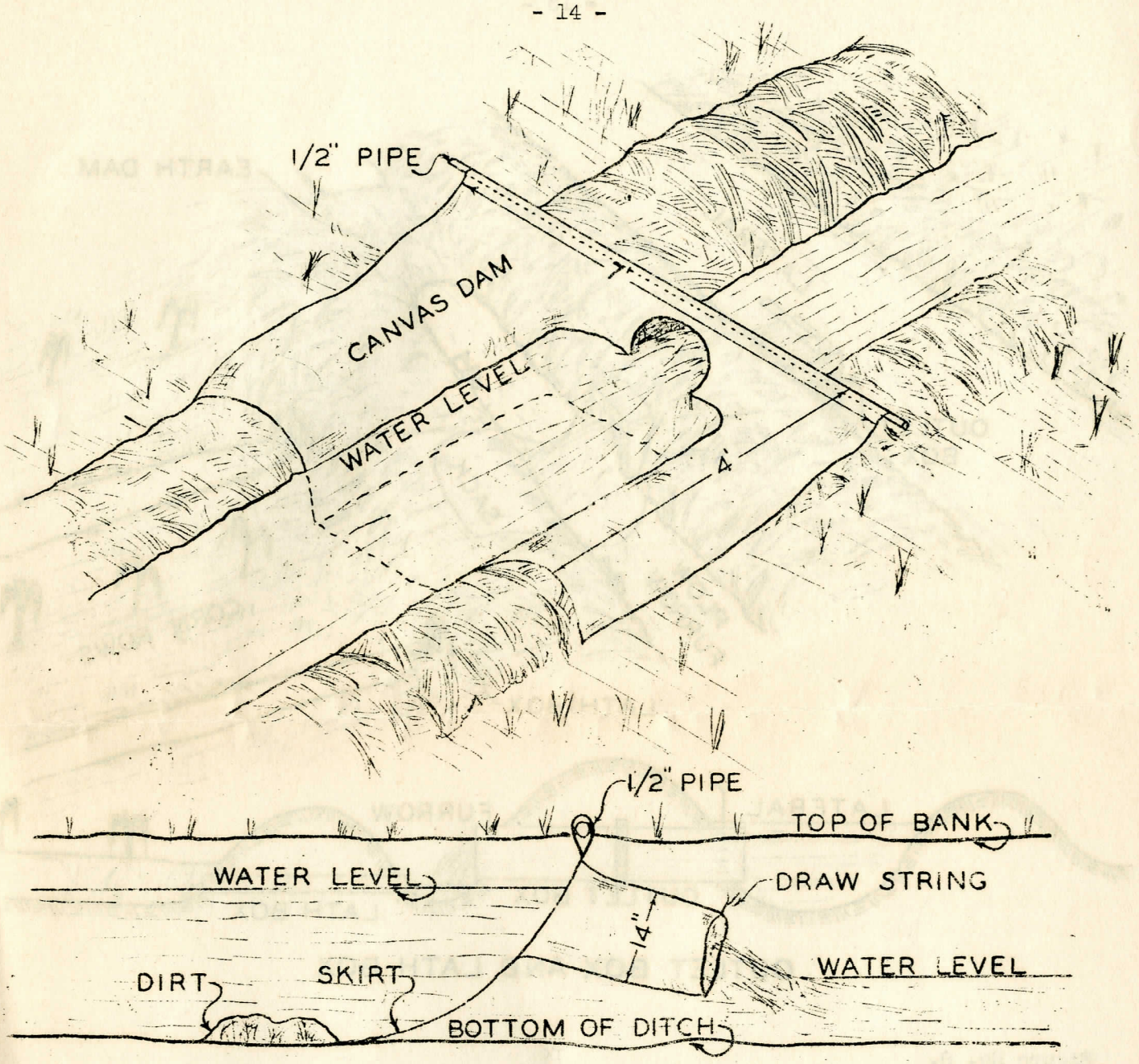



Figure No. 9. **CANVAS DAM**

Canvas dams of the type shown above are popular in irrigated sections everywhere but more especially in sandy sections where metal dams undermine easily and are difficult to hold in place. A piece of canvas 4 feet wide and 7 feet long is used, one edge of which has a hem 3 inches wide through which a piece of pipe can be inserted to lay across the ditch bank as shown.

About 4 inches below this hem in the center of the piece a hole 14 inches in diameter is cut and a "pants leg" of this diameter is sewed in place. This leg is made from 12 to 18 inches long and is fitted with a draw string, or better, a piece of fine copper wire at the outer end to control the flow of water past the dam. If it is desired that more water pass the dam, the draw string is opened just as one would open a tobacco sack.

To make a canvas dam stay in position successfully, it is necessary that the ditch banks be well soaked. The dam is laid in position as shown on the wet banks of the lateral after which the skirt is tucked into the mud with a shovel and a few shovels full of dirt thrown on the skirt to prevent under cutting.

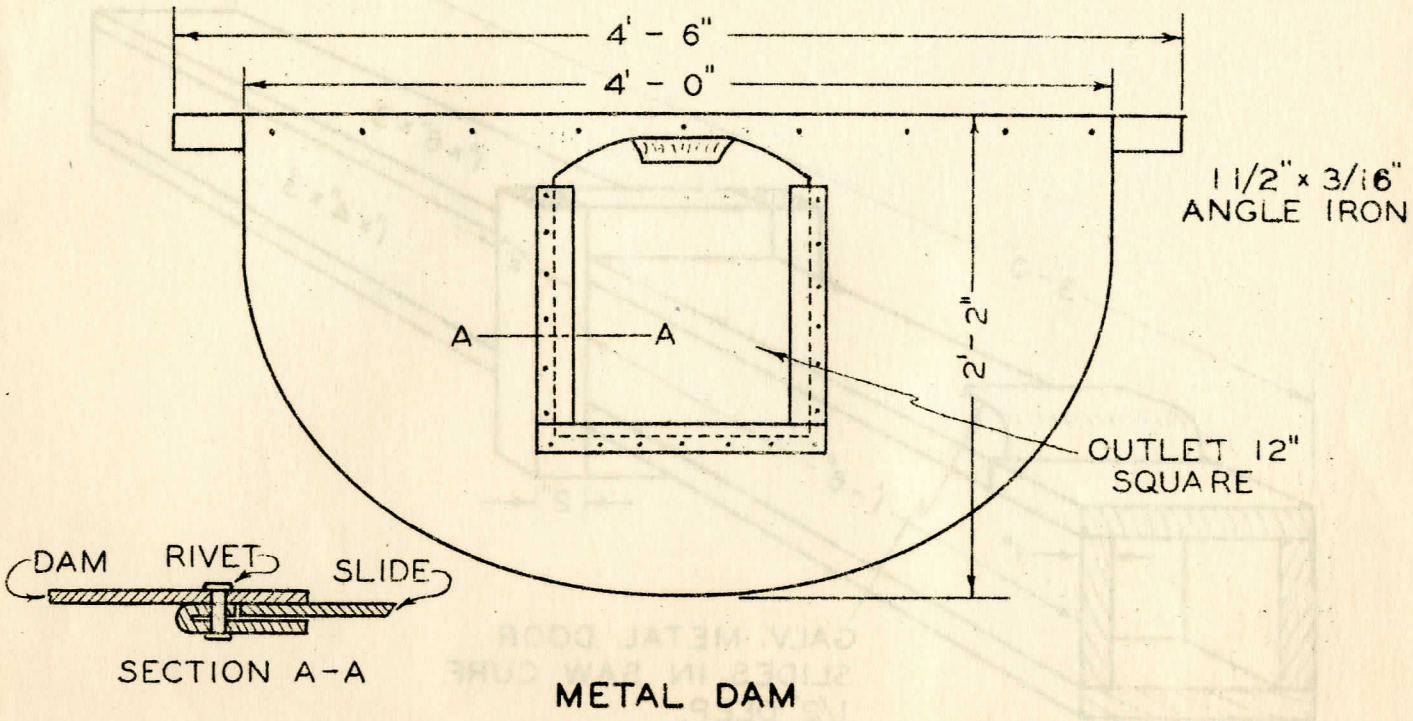



Figure No. 10.

The type of galvanized dam shown is used to raise the water level in a head ditch or field lateral in order to divert it for irrigation purposes. It is placed firmly in position in the ditch and a few shovels full of mud placed on the upstream side to prevent seepage and undercutting. If it is so desired that some of the flow be allowed to pass the dam, the slide is raised to the position which will maintain the desired head above the dam.

The size will be found adequate for most purposes, although for small field laterals a 36-inch width might suffice. The heavier the metal, the more rigid the dam. A 16-gauge galvanized iron is ordinarily used.

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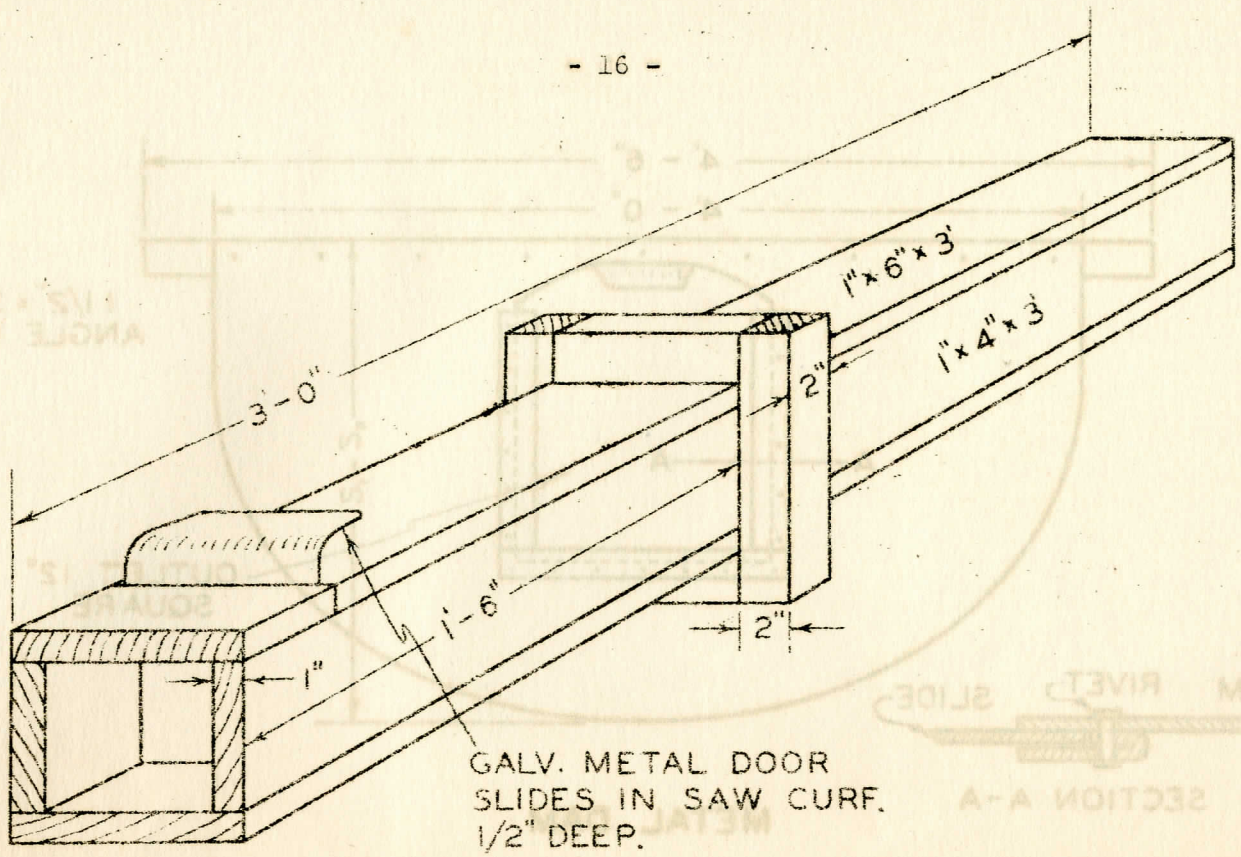


OUTLET BOX

Figure No. 11.

The outlet box shown above is used to carry water from the field lateral or head ditch to the small secondary ditch shown in Figure No. 8. The box is made by using two pieces of 1" x 4" and two pieces of 1" x 6" which gives an opening slightly less than 4 inches square. A box of this type will serve from 10 to 15 rows when the lath boxes are used. In order to give best results, a length of 3 feet is recommended.

At one end of the box a galvanized metal slide seated in a saw curf is used as a means of controlling the flow through the box. The saw curf in the sides and bottom of the box must be made before the pieces are nailed together. For the slide, 16- or 20-gauge galvanized metal is employed.

It is important that the box be water-proofed if it is to last several seasons. The best treatment consists of a creosote bath applied hot but soaking in old crank case oil or a thorough painting of the material with oil paint before nailing it together prevents warping and decay to some extent.

The 2" x 2" cleat around the center of the box is a seepage collar and assists the operator to get a water-tight setting in the ditch bank. For best results, the box should be placed in ditch banks which have been well soaked and wet earth must be compacted around it if undercutting is to be prevented.

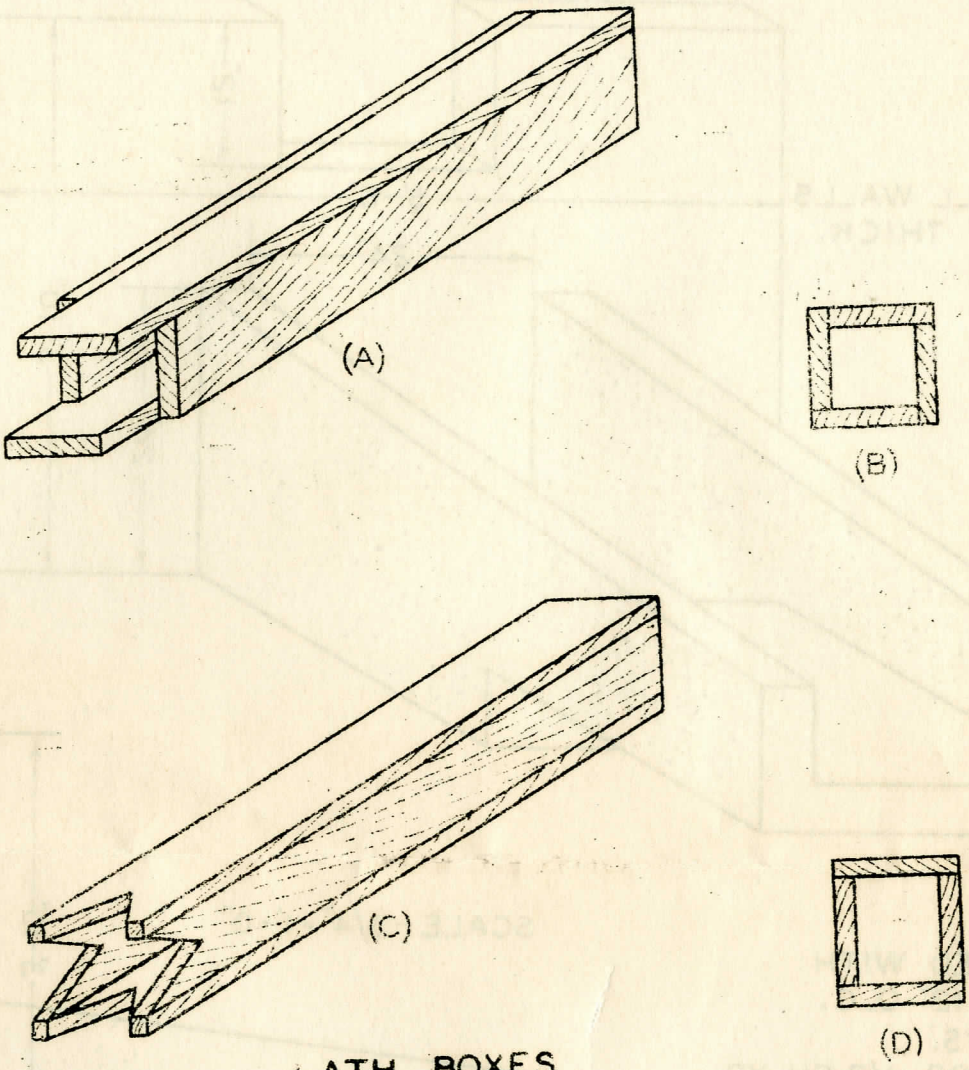


Figure No. 12.

The two types of lath boxes shown above are employed to control the flow of water from the small secondary ditch shown in Figure No. 8 to the row crop. One lath box is placed in each row and the flow is controlled by the head of water over the end of the box.

In the box shown at (A) above, two of the lath are extended to prevent it being clogged easily by floating leaves or trash. At (C) is shown a box with notches which also prevent clogging to a large degree.

Lath boxes should be waterproofed with cresote, paint or crank case oil.

In making up the boxes, four full length lath are nailed together in the manner shown and then cut in two making two boxes each 2 feet long.

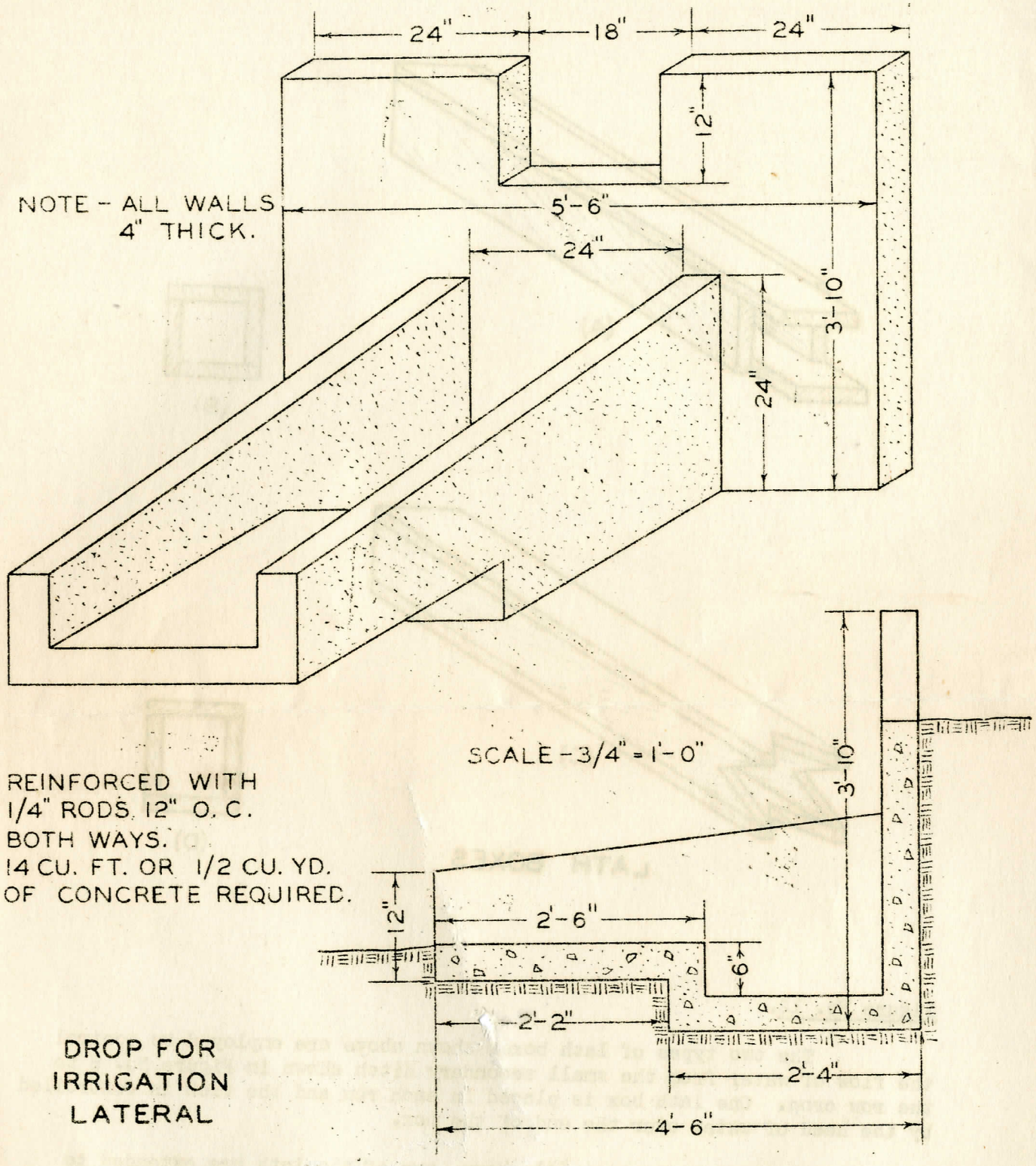


Figure No. 13.

When irrigation laterals are carried down slopes erosion often results unless drop structures are used. The drop shown above is of standard construction and with dimensions as shown will allow a drop of 2 feet. The lowered floor just below the drop forms a water cushion which absorbs some of the energy of the falling water and prevents erosion on the down stream side. By putting grooves in the sides of the notch, flash boards may be inserted to raise the water level in the lateral above.

Structures similar to the one shown above are sometimes built of creosoted lumber.

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